

has spent his labour on a work of such little real value. He seems, indeed, to have had some misgivings as to its shortcomings, and has largely borrowed from Huxley and Martin's "Elementary Biology." Thus the student is left as best he may to harmonize Thome's account of the antheridium of Characeæ, on p. 293, with Huxley's independent description on p. 294, which is transferred almost bodily.

It can hardly be doubted that Mr. Bennett, with his experience as a teacher, could have supplied us from his own pen with a text-book which would have been much more useful.

### OUR BOOK SHELF

*Natural Geometry; an Introduction to the Logical Study of Mathematics, for the Use of Schools and Technical Classes, with Explanatory Models.* By A. Mault. (London: Macmillan, 1877.)

THIS is a good elementary text-book, founded on the work by M. E. Lagout ("Takimetry"), which we have already noticed (NATURE, vol. xvi. p. 226). The ground covered by the work before us is not quite so extensive in one direction as that covered by Dr. Gwynne's translation; but it has an introduction to pure geometry which is likely to be of service to junior pupils. We are disposed to think that some such practical training as that indicated here, with the aid of the accompanying models, and a short course of "practical" geometry would be a capital thing for our junior pupils. Boys who are exceedingly dull and stupid over their "Euclid" often, as we have repeatedly seen, take much interest in these concrete exhibitions of geometrical truths. The book has been very carefully got out; there are a few loose expressions which might be improved. On p. 32 is the statement, "in equal circles equal arcs are those which have equal chords," a distinction should be made between major and minor arcs. Another trifling matter (but some boys would at once notice it) is that some equilateral figures are drawn on p. 33, which are not equilateral by scale. There are two parts—geometry by sight, which treats of the measurement of flat surfaces and of solids, and scientific geometry, or reasoning helped by sight. The latter is concerned with the measurement of accessible and inaccessible things and with the incommensurable (as the circle, sphere, cylinder, and cone). We can recommend the book for school use.

### LETTERS TO THE EDITOR

[The Editor does not hold himself responsible for opinions expressed by his correspondents. Neither can he undertake to return, or to correspond with the writers of, rejected manuscripts. No notice is taken of anonymous communications.]

The Editor urgently requests correspondents to keep their letters as short as possible. The pressure on his space is so great that it is impossible otherwise to ensure the appearance even of communications containing interesting and novel facts.]

#### The Cycle of Sun-spots and Rainfall

MAY I venture to ask insertion for the following remarks on the cycle of sun-spots and rainfall? I frequently receive inquiries regarding the meteorological aspects of the Indian famine and the prospects of Madras during the coming monsoon. But I beg to state that the object of my investigations is not at present to predict the future, but simply to ascertain the past facts. When we are quite sure of the data it will be time enough to apply them. In order to secure a stable basis it has been necessary to work up a vast accumulation of meteorological returns which have never been previously collated, and to make further references to India, Germany, and America. Some time

must still elapse before the results can be presented as a whole. Meanwhile I should be obliged if you would give insertion to the facts with regard to two points which seem at present to have a special interest to the public.

In the first place, I think I may now safely say that the coincidence of the cycle of rainfall with the sun-spot period is not confined to Madras, but is common to various points around the great ocean tract on which Madras lies. The three such points of observation for which materials exist during the most considerable period of years are Madras, Bombay, and the Cape of Good Hope. I have made up the following table from the monthly, and, when available, from the hourly, returns of these stations; and as there are a few errors (probably clerical) in a return recently given for Bombay by the meteorological reporter at Calcutta, I ought perhaps to add that these returns have been tested by a trained computator in the Scottish Meteorological office. The sun-spot column was worked out from an old list, the only one available to me in India, and will hereafter be revised from the more complete returns issued this year by Dr. Rudolph Wölf. The differences do not, however, affect the general results. My cycle of eleven years starts back from 1876; and the *minimum* group of my cycle, namely, the eleventh, first, and second years, include all the years of *minimum* sun-spots from 1877 to 1810. It will be seen that the coincidence in the cycle at Madras and the Cape of Good Hope is very strongly marked, while that at Bombay is less so, and somewhat lags behind the other two. An explanation exists for this, but it would trespass too much on your space to enter into that side of the question.

TABLE I.—*Eleven Years' Cycle of Rainfall and Sun-spots shown in Periods of Two Years.*

	Average of rainfall in inches, registered at Madras. (1813-76.)	Average of rainfall registered at Cape of Good Hope. (1842-70.)	Average of rainfall registered at Bombay. (1817-76.)	Average relative number of sun-spots (Wölf's old list). (1810-60.)
Min. group. {				
Eleventh series of years in the cycle of eleven years ...	37°03	21°19	70°32	10°92
First and second series of years in the cycle of eleven years ...	40°39	21°05	68°78	10°32
Third and fourth series of years in the cycle of eleven years ...	42°07	20°98	68°62	10°02
Fifth and sixth series of years in the cycle of eleven years ...	49°12	23°92	67°36	39°89
Seventh and eighth series of years in the cycle of eleven years ...	54°64	28°11	71°22	73°44
Ninth and tenth series of years in the cycle of eleven years ...	52°36	27°80	79°34	53°78
Eleventh series of years in the cycle of eleven years ...	49°02	23°26	76°42	33°54
Av. {				
Eleven years ...	37°03	21°19	70°32	10°92

The cyclic coincidence may be tested in another way. If it really exists there should be a well-marked minimum group at the extremities of the cycle (in the eleventh, first, and second years), and a well-marked maximum group in the middle of the cycle (the fifth and following years). The years on both sides of the central maximum group, i.e., between it and the minimum group at the two extremities, should yield intermediate results, and, when taken together, should form an equally well-marked intermediate group. I therefore divided the cycle (so far as the number 11 permitted) into three equal groups. The "minimum group" is formed by the three series of years at the extremities of the cycle, which include *all* the years of minimum sun-spots in this century from 1810 to 1877. The "maximum group" embraces the four central years from the true maximum year of the rainfall and sun-spot cycle (the fifth) to the second maximum in the sub-cycle of sun-spots in the eighth year. The "intermediate group" consists of the two series of years on both sides of the central maximum group, namely, the third and fourth years on the one side, and the ninth and tenth years on the other side.

TABLE II.—*Cycle of Rainfall and Sun-spots shown in the Minimum, Intermediate, and Maximum Groups.*

	Average of rain-fall in inches, registered at Madras.	Average of rain-fall in inches, registered at Bombay.	Average of rain-fall in inches, registered at Cape of Good Hope.	Average relative number of sun-spots (old list).
Minimum group: eleventh, first, and second years...	40°39	68°78	21°05	10°32
Intermediate group: third and fourth, with tenth and ninth years ... ..	49°07	71°89	23°59	36°71
Maximum group: fifth, sixth, seventh, and eighth years ...	53°50	75°23	27°95	63°61

I regret that I have not the materials for showing the rainfall for Bombay and the Cape during the whole sixty-four years for which the returns exist for Madras.

The other point on which I venture to trouble you at present has reference to a different class of atmospheric phenomena. I think that it may now be affirmed that a cycle of wind-disturbances exists and is coincident with, although slightly lagging behind, the cycle of sun-spots. M. Poëy called the attention of the French Académie des Sciences to this subject five years ago, and published, as far back as 1873, a list of hurricanes in the West Indies from 1750 to 1873 in support of his views. Dr. Meldrum has worked out the same question, as regards the [East] Indian Ocean, with admirable patience and success. On the publication of my cycle of Madras rainfall it struck Mr. Henry Jeula, Honorary Secretary to the late Statistical Committee at Lloyd's, that the subject might have a practical bearing upon under-writing and marine risks. He collected from Lloyd's Loss Book the statistics for the two last eleven-year cycles (1876-66, and 1865-55), the only ones for which materials were available; and conjointly, we have tabulated the results. We found that the percentage of losses on registered vessels of the United Kingdom was 17½ per cent. greater during the two years of maximum sun-spots (the eleventh and first of the cycles) than during the two years of minimum sun-spots (the fifth and sixth of the cycles). In the same way we found that the percentage of the total losses (calculated on the eleven years) posted on Lloyd's Loss Book was 15 per cent. greater during the two years of maximum than during the two years of minimum sun-spots. We further found that the increase and decrease of losses follows a cycle, closely following (although for sufficient reasons somewhat lagging behind) the cycle of sun-spots. These results can be tested from the succeeding tables.

TABLE III.—*Percentage of Losses posted on Lloyd's Loss-Book, compared with the Eleven-Year Cycles of Sun-spots and of the Rainfall at Madras.*

	On registered vessels of the United Kingdom.	On total losses posted in eleven years.	Average of rain-fall at Madras. Inches.	Average relative number of sun-spots (Wolf's lists).
Minimum group: Eleventh series of years of the cycles ... ..	9°93	7°64	37°03	10°9
Average of first and second years of the cycles ... ..	11°91	9°33	42°07	10°0
Average of third and fourth years of the cycles ... ..	11°05	8°64	49°12	39°8
Average of fifth and sixth years of the cycles ... ..	12°21	9°31	54°64	73°4
Average of seventh and eighth years of the cycles ... ..	12°82	9°81	52°36	51°7
Average of ninth and tenth years of the cycles ... ..	11°84	9°09	49°02	33°5
Average of eleventh years of the cycles ... ..	9°93	7°64	37°03	10°9

Dividing the eleven years as nearly as the number admits by three, into a minimum, an intermediate, and a maximum group, we get the following results:—

TABLE IV.—*Percentage of Losses posted on Lloyd's Loss-Book, compared with the Eleven-Year Cycles of Sun-spots and of the Rainfall at Madras.*

	On registered vessels of the United Kingdom (1855-1876.)	On total losses posted in each eleven years (1855-1876.)	Average of rain-fall at Madras. Inches (1873-1876.)	Average relative number of sun-spots (Wolf's lists) (1870-1866.)
Minimum Group. Average of first, second, eleventh, and tenth years of the cycles ... ..	11°13	8°64	41°58	14°26
Intermediate Group. Average of third, fourth, ninth, and eighth years of the cycles ... ..	11°90	9°21	51°37	42°46
Maximum Group. Average of fifth, sixth, and seventh years of the cycles...	12°49	9°53	53°22	64°10

Again, testing the cyclic coincidence, by taking the first four years, the middle or maximum four years, and the remaining three years at the end, a similar result is obtained.

TABLE V.—*Percentage of Losses posted on Lloyd's Loss Book, compared with the Eleven-Year Cycles of Sun-spots and of the Rainfall at Madras.*

	On registered vessels of the United Kingdom.	On total losses posted in eleven years.	Average of rain-fall at Madras. Inches.	Average relative number of sun-spots (Wolf's lists).
Average of first, second, third, and fourth years of the cycles ... ..	11°49	8°93	45°00	24°90
Maximum Group. Average of fifth, sixth, seventh, and eighth years of the cycles ... ..	10°52	9°56	53°53	63°55
Average of the ninth, tenth, and eleventh years of the cycles ... ..	11°20	8°61	45°02	25°99

I think, therefore, that we are justified in concluding that the periodicity observed by M. Poëy in the hurricanes of the Antilles, and by Dr. Meldrum in the cyclones of the Bay of Bengal is of such a character as to exercise a widespread effect upon the commerce of the world. How far these wind-disturbances may be eventually proved to be general throughout the earth's atmosphere, or throughout any given belt of it, I am not yet prepared to offer an opinion. But that the practical results of such wind-disturbances on maritime commerce are of a general character the foregoing tables now place beyond dispute.

In conclusion, I beg to caution fellow-workers that no really trustworthy results are to be obtained from the old plan of jumbling together a number of unhomogeneous stations in a bag and shaking out averages. The true method is to take certain recognised factors in the rainfall, such as the monsoons, and to examine whether any common periodicity exists between the operation of these factors and the sunspots. This is what I have attempted to do for various points around the great basin which stretches southwards from the Bay of Bengal, and what Mr. Archibald has so carefully done in NATURE for Northern India. I am now conducting a similar inquiry into the American and Australian rainfall, but, as already stated, some time must elapse before the results can be presented.

W. W. HUNTER

Allanton House, Lanarkshire, September 20

#### The Discovery of the Satellites of Mars

As some of the earlier newspaper accounts of Prof. Hall's discovery of satellites of Mars are said to have produced, in some